

## **The feedback for user- centered design from consumer's perception of the smart kitchen**

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### **Abstract**

This study aims to analyze what the users want in a smart kitchen, so that a design centered on the Smart Kitchen can be realized in a quality smart living space. This enables designers to address the characteristics and requirements of clients and design adequate user interface and functionality, and let the users get closer to have better and more convenient products. The study adopted focus group interview to collect the main users' expectation about the Smart Kitchen to help the designer to deeply understand their needs. Secondly, we employed purposive sampling to conduct the research; the sample primarily came from the five metropolitans and two sub-metropolitans of Taiwan. The selected samples were the main users of home kitchen and their houses had to be equipped with the related equipments (such as computer and Internet). The research was to analyze the users' attitude toward the Smart Kitchen's importance and degree of demands. We utilized importance-and-degree of demands analysis (IDA) to evaluate the demands of the Smart Kitchen's equipments to be the priority for the designer to design the Smart Kitchen. Finally, to provide base for market segmentation, we conducted independent sample t-test to explore the variance of different sample users' attitude toward the Smart Kitchen.

The results from focus group interview indicate that the difference of kitchen usage between housewives and career women could be the reference of market segmentation and the base of making marketing strategy. Under the lifestyle of modern business society, people are always busy, family members need time and space to interact, and kitchen is therefore the place for dining and parent-kid's interaction and communication. Hence, spatial layout is one of the points to design the Smart Kitchen. Notably, safety remains the most urgent needs when designing the Smart Kitchen based on the suggestions provided by the users. In a housing space, an interactive monitor is necessary because females also hope to take good care of kids when they are working in the kitchen.

The results from questionnaire survey indicated that the importance and extent of demand on functions and equipments of the Smart Kitchen is positively pair wised correlated. The main user stated the prior functions could be reference for the designer's when designing the system. The factor's ranking of the main user's attitude toward the function and demand of the Smart Kitchen is as the following: safety, energy-saving, health, convenience and comfort. Kitchen's

functions need to get advanced from basic needs to enjoyed needs.

Key words: living space, smart kitchen, importance, demand

## **I. Introduction**

### **1.1 Preface**

In view of global climate change and rising international energy prices, energy-saving and carbon reduction has become a universal value. According to the Bureau of Energy, a division of Ministry of Economic, Monthly Energy indicators showed that from 1990 to 2008, residential and commercial electricity consumption increased from 20.85% to 23.26% in Taiwan's total consumption. In particular, 11.54% of electricity consumption was used in residential section (Bureau of Energy, 2009). Therefore, in order to achieve the target set for 2025 in residential and commercial building energy conservation, at least 7,000,000 more homes with renewable energy are required. In addition, consumers have been expecting high-tech development to bring more user-friendly and convenient applications and services, and this has not been met. This led to the issues of Smart Living Spaces, including the emerging applications and services of Wireless Sensor Networks (WSN) and Ubiquitous Network Society (UNS).

Through UNS, the user can acquire personal services easily from various environments such as office, home, public space, or transport facilities, by using computers, mobile phones, home servers and other electronic equipments. At present, countries all over the world are developing application services in numerous directions. Taiwan can take a page out of the two neighboring countries of Japan and South Korea. The Japanese government in 2004 proposed the "U-Japan" concept in order to achieve UNS. It further launched the "xICT" policy in 2008, featuring industry and region as two new ingredients in response to the global trend, while keeping the framework of "U-Japan". The South Korean government also launched in 2004 the "U-Korea" strategy and its precursor "IT839", to use UNS technology as the core to form 8 Digital Services, 3 Infrastructures and 9 growth power industries. It is clear that UNS application services have become a key developing strategy in Japan and South Korea.

### **1.2 Research background and Motivation**

The main subject of this study is the Smart Kitchen, we would like to stress that, besides the basis function of a kitchen, high-tech hardware and software should be applied to the Smart Kitchen to meet the users' demands, convenience and comfort. The basic functions of the kitchen include: cooking, drinking water, cleaning, and storage and so on, and a space for family members to chat and communicate. Therefore, the kitchen space in a family home plays a rather important role, and all family members are users for this space. The kitchen/dining room is a space that the whole family must use every day. Past research indicated that, the kitchen is a relatively hazardous place in home for the senior, juvenile, or handicapped members of the family. This has an impact on the frequency and duration for these members to use the kitchen. Therefore, an energy saving, safe, comfortable, convenient and healthy kitchen environment is a top priority in home design.

In addition, the gender of family members is also a factor in the frequency and duration of using the kitchen. According to the DGBAS survey in 2004, 31.3% of men in Taiwan participated in domestic chores. This rate is much lower than that of France and the United

States, and higher than that of Japan. On the other hand, 75% of Taiwanese females participated in household chores. Again this rate is lower than that of France or the United States, and is slightly higher than that of Japan. This shows that in Europe and the United States, both genders participate in household chores more than in Asia. In all countries, the females do more domestic chores than the males. The gap between the two genders is most pronounced in Taiwan and Japan, amounts to 43.7 and 57.8 percentage points respectively (DGBAS, 2005). Since using the kitchen is a significant part of domestic chores, one can deduce that the women are the principal users of the kitchen equipments and spaces. Past studies have shown that the traditional ideal of "men fight out, women stay in" in Asia is still influential in Asia, and even professional women use the kitchen longer and more frequently than men, and they discipline their children with this idea. Consequently, young girls in the home are often instructed to learn the ways in the kitchen. In view of this, a kitchen designer must consider the need of female users in a functional design.

As the Smart Kitchen differs from a traditional one in its uses of high-tech hardware/software in the equipments, in addition to basic functions, it is necessary to consider the female acceptance to such technology, as they are the principal users. In the past, women have been regarded ill-fitted to science and technology, and some even consider their slowness in adapting information technology as an inborn or social trait. Many scholars pointed to the difference in male and female physiology for their difference in expertise. For example, men are better in mathematics and logic, and women are more talented in languages and social skills. Therefore, the computer and information industry was a male-dominated one. From design to career promotions, everything is completely centered on males.

According to a survey by the U.S. cable television company Oxygen Media, the trend has changed: there was a huge increase in female uses of technology products, and the gap is closing significantly. Most American women can quickly adopt a new technology and use it skillfully. An average American woman owned 6.6 electronic gadgets, while the American man owned 6.9. Also, 80% of women feel no obstacles in using technological products, and 46% of them can deal with computer problems. Therefore, the women are essentially as good as the men in using technology now.

Taipei Computer Association also found that IT consumer market has changed accordingly. The women have become such important consumers of 3C digital products, which the manufacturers have to target the female buyers and to design products to meet the female's liking. If we look at the sales figure, the worldwide sales of consumer electronic products to female customers amounted to 55 billion U.S. dollars in 2003, exceeding the figure of male customers for the first time in history. Therefore, the women, who were often neglected in the past, have officially become the most important consumers. This shows that women and technology go well together, and more and more women enjoy using technology to make their lives more interesting and convenient. This is an enormous business opportunity, and it pushes manufacturers and designers to focus on female user centered designs. This is a trend that we emphasize in this study.

### **1.3 The Purpose of This Study**

In accordance with the background and motivation discussed above, this study polled on homes within five metropolitan regions and two sub-metropolitan regions. We targeted homes with IT equipments (computers and internet) and their principal users of the kitchen, and

conducted a questionnaire survey to explore consumer's cognition of Kitchen functions, to analyze their unmet needs in the kitchen, to pinpoint elements for better designs. Secondly, we differentiate the expectations of the Smart Kitchen from different family members, and divide the consumers into different "consumer groups" based on the types of families, to serve as a reference for market segmentation of the Smart Kitchen. Finally, we studied the extent of user's needs of the Smart Kitchen, and we hope that our quantified questionnaires and analysis will be useful for designers for their subsequent designs. More specifically, the purposes of this study are as the following:

1. Analysis of the kitchen users' expectation and knowledge regarding the Smart Kitchen, its functions and equipments. Find out the unsatisfied demands and the conditions for a kitchen-centered quality home environment.
2. Analysis of the differences in perceptions of importance and necessity of the Smart Kitchen equipments and functions among family members, in particular, the safety requirements for handicapped, seniors and children, and the demand of female users, who will use the kitchen most frequently. The cross analysis will be a useful reference for future designs.
3. Dividing the consumers into groups according to family types, and analyzing the differences in their priorities regarding kitchen equipments and functions, for applications to meet the essence of market segmentation.
4. Analysis of the kitchen users' acceptance of technology products for the Smart Kitchen equipments and functions and its relevance to their demands.

## **1.4 Research questions**

As mentioned above, this study intended to integrate the literature on consumers' demands on the Smart Kitchen equipments and functions, and made further empirical research. We hope to gain more insight into the dependency on family types and family members.

In marketing theory, the decision-makers usually make different marketing strategies based on different groups of consumers, target customer's characteristics and demands. The designers, however, often consider from the viewpoints of users and design to meet the needs. Therefore, in this study, to realize a Smart-Kitchen centered design in a quality living environment, we first analyze the need of the users. Therefore, we propose to explore the following questions:

1. What is the impact of family types and family members on the perception of significance and necessity of the Smart Kitchen features?
2. Is the principal kitchen user's acceptance of technology a factor in their perception of importance and necessity of the Smart Kitchen features?

## **II. Literature Review**

### **2.1 User's demand and acceptance**

The word "demand" contains three different meanings: (Husen & Postlethwaite, 1985): First, a demand is a gap, which recognizes the inconsistency of the target and the reality, that is, the difference between target status and actual status. Second: a demand is a want or a preference, the state of wanting or preferring, and in determining the demand we do not need to

determine the target status and the actual status or their difference, just the subjective perception of wants or preference. Third: a demand is a deficit, (Scriven & Roth 1978), i.e. the entity does not meet the demand or to maintain a minimum standard of satisfaction. Applying these three interpretations of "demand" to the Kitchen, the object of this study, we see that there are three related issues:

1. At present, the kitchen equipment does not meet the user's actual needs, and there is a gap. For example: in an apartment with limited living space, the need to make the best use of the kitchen space to cope with varying size of a dining party is not met.

2. Understanding the kitchen user's subjective wants and preferences of the space environment. For example: automatically control the air conditioning during cooking and dining, in accordance with indoor temperature change, to maximize the user's subjective perception of comfort.

3. The kitchen's deficit in facilities/software makes it unable to meet the minimum level of satisfaction. For example: the kitchen is isolated from the living space improperly, and hence the kitchen users cannot monitor the young children in the bedroom. Therefore, this study first explored the users' demands of the Smart Kitchen, for the future integration and reference for designers.

Maslow's theory of needs hierarchy (Abraham H. Maslow, 1954) can be utilized to explain the various needs of users of products. The theory classifies human needs into many different levels, including physiological needs, security needs, affiliation needs, esteem needs, and self-actualization needs. As there are many categories of needs, there are corresponding attributes of products to meet the psychological needs of users. Therefore, the technology of producing products must always be innovated and changed to meet all the needs, not just the physiological and security ones. That is, the user's desire for a product comes from the needs in multiple categories, and we must consider the more intrinsic psychological needs in addition to the obvious physiological needs.

In addition, Elizabeth (Elizabeth 1993) proposed more specifically that the three basic needs to satisfy a user are: usefulness, usability and desirability. In particular, a user interface which can be used and easily understood by users of all ages and genders is most helpful in making a product be popular. Yu (Yu 1998) pointed out that the development of electronic product is subject to the rapid development of the technology, and becomes diversified. Whether the usability and product information can be correctly and completely conveyed to the users is absolutely related to the product's acceptance. Operational problems encountered by users are also influential in the acceptance of a product on the market, and is an important factor in its success or failure on the market.

## **2.2 Assessing the needs of users**

To know and analyze of the needs of the users is not easy for a designer. This is because of that it is not always easy to detect the needs of the users. When a user's need is not obvious, it doesn't mean that the need is not there; it is just that the need is obscure or not strongly perceived. This can only be resolved by diverse assessment model for user's needs. Only by using a complete analysis of user's need in the design, we can give the users the better product interfaces and operation methods, and improve the usefulness of the products. From the viewpoint of consumer behaviors, the adopting situation of a product affects the consumer behavior, and is subject to what the consumers' perception of the product characteristic and image. The

characteristic and image varies with the environment. As the consumption happens in the adopting situation, the marketers must understand which situation their products belong to. Such information will enable the marketers to successfully sell their products to consumers in various situations.

Similarly, from the viewpoint of user's behaviors, the adopting situation of a product also affects the user behavior, and the designer must understand the situation of his design. This information can bring his design closer to the user's life, and even make the users prefer his design. In other words, the key to satisfy a user is to provide the designer with the user's desired function in the relevant situation, so that the need can be met.

It is worth mentioning the concept of "User-Centered Design" (UCD), in which the product design is centered on users and this helps the designer to perceive and analyze the users' need. By analyzing the users' objectives and activities, mode and environment of operation, the designer can repeatedly redesign and test the products. Simply put, UCD emphasizes meeting the users' expectation, and produce product of their hearts' desire.

### **2.3 User's demand and interactive design**

The object of this study, the Smart Kitchen, also stresses an interactive system design. The ISO 9241-10 gave the principles of interaction design and pointed out that the interaction between a user and an interactive device should be in accordance with software ergonomics, and meet the seven principles for evaluations and applications: task adequacy, operability, consistency, fault tolerance, self-describability, personalization, easy to learn. Moreover, Oviatt (Oviatt 1997) also mentioned in his study of multi-modal interaction that the four principles of interactive designs are: transparent, flexible, efficient, and expressive powerfully. A designer can use these principles to make UCD.

In this study, we used questionnaire to survey the user's cognition, needs, and expectations. For example, we designed a questionnaire to understand the users' demand and acceptance of the Smart Refrigerator, its storage, health message, purchasing guides, recipes, and video/audio functions. We analyze the user's expectation and knowledge of the Smart Refrigerator. We also study whether the users understand that a Smart dining chair can adjust its functions according to the human body, the functions of a desktop living assistant, whether interactive games are interesting, whether the Smart Kitchen improve the family life. In addition, we also try to understand whether the users know about the interactive view windows in a kitchen, the security alerts, the energy-efficient lighting designs and whether they meet user's need in security, environment protection, and comfort in a Smart Kitchen. By constructing and better quality Kitchen, we can improve the living quality.

### **2.4 Gender, family type and family members and the demand in the kitchen use**

According to past research, the family type in a home has an impact on the gender division of labor. For example, women in a nuclear family are usually career women, and the main person doing household chores. But in an extended family, these tasks may be divided between a mother-in-law and a daughter-in-law. She also noticed that eating-out is a common practice now. A young couple in 1999 was more likely to eat out than one in 1970, even after marriage. In 1999, a young husband is less likely to subject to the traditional view of genders, and less likely to regard cooking as the task of a wife. He may participate in cooking himself. Thus we see

that different family types lead to different patterns in family members' usage of the kitchen. Therefore, in our study we used the relevant survey by the Directorate General of Budget and divided family types into the categories such as: single-person household, single-parent family, couple without children family, nuclear family, grandparent-grand child family and extended family. We hope that this survey and analysis on the usage demand among family members of various types of family will be an inspiration for designers. The kitchen is a central part of family life, and must satisfy each individual family member. The difference in family types is seen in the size of the family, the gender ideology, the gender division of labor, the use of kitchen functions. Therefore, our study focused on how family types impact the demands in a Smart Kitchen, instead of just the living style of users, which is done in most product designs.

Standardized products are not enough for special group of people. They often want a more individualized or custom-made design. Therefore, there are personalized functions. Currently, there are many different forms of personalized services provided by Internet Service Providers. Caglayan and Harrison (1997) grouped these services into three types: customized, learning user interests, and learning community behavior.

This study targeted career women (with better financial ability, greater requirement in efficiency, and better acceptance in technology), senior citizens and children (who have higher demands in security), and men (who may be less experienced in family chores), and survey their demands in the Smart Kitchen and analyze the difference. We also study the families consisting of such members, and hope to apply the survey result to customized kitchen equipment design. We combined ideas from other sub-projects to understand the user's demands and acceptance by our empirical studies. For example, to use IP camera to shorten the virtual distance so that the image of young children in a bedroom can be seen in the kitchen, and they can be pacified by audio and video; to use RFID-equipped kitchen appliances; a interchangeable user interface, a chair that adjust its height automatically according to the user, a software that learns and manage itself, a detector of what one carries when going out. All these functions rely on smart services based on recognition of family members.

### **III. Research Design**

#### **3.1 Focus group interview**

The study conducted focus group interview to collect the interviewees' opinions or expectations toward the Smart Kitchen. The interviews were held on two stages at the U-Home of Kun Shan University, Taiwan; one was from 9:30 am to 11:30 am, May 7<sup>th</sup>, 2010, while the other was from 1:30 pm to 3:30pm, May 21<sup>st</sup>, 2010. Each time we invited 6 to 8 professionals or users to participate in the interview, the topics were focused on the users' expectation, needs and psychological perception toward the Smart Kitchen. The process lasted for 2 hours, and the interviewees autonomously interacted and stated their opinions. The interviews ended when the researcher judged that the data collection was well done.

##### **1. Group Composition**

The members of the focus group were from different families (see Table 2). Furthermore, to make the members' background as heterogeneous as possible, we also invited kitchen appliances practitioners to participate in the interview. Each one posed issues and discussed intensively about the kitchen using experiences. Please refer to Table 2 for the demographics of the interviewees.

Table 2 Demographics of the interviewees

**The ERES Conference**  
**June 23~June 26, 2009, Milano, Italy**

Interviewee	Stage 1				
	A-1	A-2	A-3	A-4	A-5
Gender	F	F	F	F	F
Age	41	47	43	47	41
Full time employed	Y	Y	Y	Y	Y
Education	Graduate school (and above)	Graduate school (and above)	Graduate school (and above)	Graduate school (and above)	Graduate school (and above)
Marriage	Married	Single	Married	Married	Married
Number of kids	0	0	2	2	2
Times to cook daily	Two times daily	Once a day	Less than one daily; About once weekly	Two times daily	Once a day
Daily Internet hours	1 to 2 hours	4 hours (and above)	2 to 3 hours	1 to 2 hours	3 to 4 hours
profession	Educational service industry	Educational service industry	Manufacturing industry	Educational service industry	Educational service industry
Source of income	Double income	Single income	Double income	Double income	Double income
Average monthly income (NT)	NT\$ 90,001~150,000	NT\$ 90,001~150,000	NT\$ 90,001~150,000	Above NT\$150,001	Above NT\$ 150,001
Family type	Couple without children	Nuclear family	Three-generation Family, member of 2 <sup>nd</sup> generation	Nuclear family	Nuclear family
Number of kids aged under 6 years	0	0	0	0	0
Number of kids aged between 6-18 years	0	0	2	2	2
Number of kids aged above 18 years	0	0	0	0	0
Number of seniors aged above 65 years	1	1	0	0	0
Number of people with disabilities	0	0	0	1	0

**Table 2 Demographics of the interviewees (Continued)**

Interviewees	Stage 1			Stage 2	
	A-6	A-7	A-8	B-1	B-2
Gender	F	F	F	M	F
Age	43	55	50	45	55
Full-time employed	Y	N	N	Y	N



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Education	Graduate school (and above)	University/ College	University/ College	University/ College	University/ College
Marriage	Married	Married	Married	Married	Married
Number of kids	2	3	2	2	2
Times to cook daily	Less than 1 daily;	Once daily	Once daily	Once daily	Once daily
Daily Internet hours	2 to 3 hours	Less than 1 hour	1 to 2 hours	4 hours (and above)	2 to 3 hours
profession	Educational service industry	Educational service industry	Educational service industry	Manufacturing industry	Government employee
Source of income	Double income	Single income	Single income	Double income	pension
Average monthly income (NT)	NT \$ 90,001 ~ 150,000	NT \$ 90,001 ~ 150,000	NT \$ 67,001 ~ 90,000	NT \$ 67,001 ~ 90,000	NT \$ 90,001 ~ 150,000
Family type	Nuclear family	Nuclear family	Nuclear family	Nuclear family	Couple without children
Number of kids aged under 6 years	0	0	0	0	0
Number of kids aged between 6-18 years	2	1	0	2	0
Number of kids aged above 18 years	0	2	2	0	2
Number of seniors aged above 65 years	0	0	0	0	0
Number of people with disabilities	0	0	0	0	0

**Table 2 Demographics of the interviewees (Continued)**

Interviewees	Second stage			
	B-3	B-4	B-5	B-6
Gender	F	F	F	M
Age	68	39	45	58
Full-time employed	Y	Y	N	Y
Education	High school	Graduate school (and above)	University/College	High school
Marriage	Married	Married	Married	Married
Number of kids	3	1	1	4
Times to cook daily	2 times daily	once daily;	2 times daily	2 times daily
Daily Internet hours	Less than 1 hour	Less than 1 hour	4hours (and above)	Almost zero
Profession	Professional, scientific and technical service industry	Educational service industry	Educational service industry	Whole sale and retailing

**The ERES Conference  
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Source of income	Double income	Double income	Single income	Double income
Average monthly income (NT)	NT \$ 48,001~ 67,000	NT \$ 90,001~ 150,000	NT \$ 90,001~ 150,000	NT \$ 90,001~ 150,000
Family type	Couple without children	Nuclear family	Three-generation family	Nuclear family
Number of kids aged under 6 years	0	0	0	0
Number of kids aged between 6-18	0	1	1	1
Number of kids aged above 18 years	0	0	0	0
Number of seniors aged above 65 years	2	0	3	0
Number of people with disabilities	0	0	1	0

## 2. Procedure of the focus group interview

We outlined the topics before conducting the focus group interview, the objective was to understand the following three topics: 1. the interviewees' expectation toward the Smart Kitchen in terms of different family styles; 2. the usage and suggestions of kitchen space provided by the interviewees; 3. the suggestions about the Smart Kitchen's functions.

During the process, the interview started right after the researcher introduced the background of the research, objective and the interviewees' background. In the first stage, for the interviewees' were with high homogeneity, they had intensive discussion and interaction. The contents were focused on the problems or experiences they had ever confronted with when using kitchens at home. The process was digitally recorded and transcribed after finishing the interview. And we then conducted content analysis to induct all different attributes and dimensions. The results were finally analyzed.

## 3.2 Quantitative questionnaire survey

### 1. Subjects

We used Directorate General of Budget's "2007 overview of computer applications". It showed the popularity of family computers and home internet. We saw that currently internet is more popular in the five metropolitan regions and two sub-metropolitan regions. Therefore, we set the targets of this study to be people meeting the following conditions: (1) the main users of the kitchen at home; (2) his/her home should have IT equipments (computers and network); (3) he/she lives in the five metropolitan regions or the two sub-metropolitan regions.

### 2. Design of questionnaire

In our questionnaire, each question is formed after Likert's scale 5 point scale, "1" for strongly disagreeing, and "5" for strongly agreeing. We now describe the content design of the questionnaire.

- (1). Importance: we designed a total of 36 questions to measure the subjects' view of the importance of the Smart Kitchen: 11 questions on safety features, 7 on health function, 6 on energy-saving features, 6 on convenience, and 6 on comfort features.

- (2). Demand: there are also a total of 36 questions designed to measure the subjects' demand on the Smart Kitchen: 11 questions on safety features, 7 on health function, 6 on energy-saving features, 6 on convenience, and 6 on comfort features.
- (3). Technology acceptance: we devoted 8 questions to test the subjects' acceptance to technology products.

### 3. The sample survey and effective sample structure

Subject to the above conditions, we chose people living in the five metropolitan regions or the two sub-metropolitan regions with IT equipment (computers and Internet) at home and being the main users of the kitchen, for the questionnaire survey. We send out a total of 1,445 paper copies of questionnaires and 213 web questionnaires, and 1185 were sent back to us. This yields the response rate of 72.79%. After eliminating the invalid sample, we received 1001 copies of valid responses, this makes the valid returning ratio turns out to be 60.85%. The sampling is under 95% of confidence level and 3% of sampling error.

## IV. Findings of the focus group interview

### 4.1 Housewives hoped that kitchen could be the space for family to interact and cultivate affection

“Family” is the living core of housewives. However, in Taiwan, husbands have to go to work everyday and kids also go to cramming schools almost every day, this leads to the times of “eating in” are rare, and the opportunities for housewives to prepare for meals are significantly reduced. The housewives emphasized the time to be with family members and hoped that kitchen and dining space should be the space for family to interact and cultivate affections.

In the interview, the housewives expressed that the time for them to deal with housing affairs was not bounded because they stayed at home longer than the other family members. Therefore, their demands were not related with fast dealing with housework, but they hoped that the Smart Kitchen could keep the sense of fragrance and not to be so electrified. Because they did not have much time to be with their families, the face-to-face conversation and interactions among family members looked more precious.

### 4.2 Career women hoped that kitchen should be equipped with simple, clean and effective appliances so that their burden could be reduced

In Taiwan, career women have to work every day, they need to prepare for meals, do laundry or housework after working, so they remain the principal house workers and have to shoulder the pressures that come from family and job.

Presently, it is rare for the members of double income family to eat in; sometimes they bought take-outs or have TV meals. So they hoped that kitchen could be equipped with basic and clean implements.

In the interview, the career women firstly pointed out that they hoped the Smart Kitchen could help them to shorten the cooking time and effectively process housework. For example: the leading/cooking time could be reduced through the help of food processor or food waste

disposer so that they could save time and energy on doing house work.

Secondly, they hoped that the Smart Kitchen could also be melted with the factor of “space” and combine the element of “communication and interaction”. When they come home to cook, it’s also the time for kids to do home work after school. If the spatial layout is well designed, they’ll be able to interact with their kids when working in the kitchen.

#### **4.3 Male users hoped that the circulation of the kitchen could be well designed, it’s easy to get utensils and the kitchen should be with the function of entertainment**

Males cook generously and speedily, so they hoped that the circulation of the kitchen should be fluent. The receiving function and spatial layout should be taken into consideration when designing; condiments should be easy to get and utensils could be fast reached. Additionally, for single male users, kitchen should be with more entertaining functions, such as liquor cabinet, counter and dart, so that they could enjoy living when cooking. Cooking would thus be a pleased enjoyment.

#### **4.4 Kitchen appliances practitioners: Designed kitchen appliances have been highly advanced with the times, however, in Taiwan; the smart home electronic appliances are still hard to be delighted by the consumers**

The kitchen appliances practitioners specially pointed out that with the revolution of the times; kitchen has been the core of family life, i.e., the concept of “kitchen is living room” has been accepted. Kitchen should be clean and tidy, and storage and receiving should be the important points when designing the kitchen, so that the family members would like to get close to it. Meanwhile, kitchen should be where for family to dine, interact and have a meeting with good friends and family members. Therefore, in modern society, kitchen is a good place for social interaction. Moreover, the kitchen appliances should not be so solid and cold; they should be integrated with the concept of humanity and art.

In addition, the practitioners of Taiwan have developed some advanced cooking appliances such as gruel cooker, which also makes smoothie and yeast bread dough. However, the domestic consumers seldom bought it, the product is mainly for exporting to the west, it is deeply delighted by the western consumers.

## **V. Statistical analysis**

### **5.1 Analysis of personal background information**

We analyzed the 1001 valid samples according to their personal background information. One can see that the female (810 persons, 80.9%) far outnumbered the male (191 persons, 19.1%), 446 persons (44.6%) have 2 children or less, and 335 persons (33.5%) are single. 870 (86.9%) of the respondents have a high school diploma or higher, and 67.6% of them go online one hour or more everyday. 53.7% of them prepare a meal daily, or less frequently. 506 (50.5%) of them belong to a core family, 119 (11.9%) to a 3-generation family (among these, 83.6% are second generation members in the family). 200 respondents (20.0%) have a child of age 6 or less, 358 (35.8%) of them have a child of age 6-18, and 350 (35%) of them have a child older than 18. Moreover, 192 (35%) of them have a family member of age 65 or older, and 48 (4.8%)

have a family member with disability.

Table 1 Background of the respondents

Demographics		Number (person)	Ratio (%)
Gender	Male	191	19.1
	Female	810	80.9
Age	Under 30	260	25.97
	31-40	344	34.37
	41-50	266	26.57
	51-60	117	11.69
	61-70	14	1.40
Full-time employed	Yes	740	73.9
	No	261	26.1
Education	Elementary School	53	5.3
	Junior middle school	78	7.8
	Senior high school	345	34.5
	University or college	423	42.3
	Graduate school (or above)	102	10.2
	others	5	0.5
Children status	No children	395	39.5
	One or more	606	60.5
Times to cook daily	3 times daily	154	15.4
	2 times daily	310	31.0
	Once a day	335	33.5
	Less than one daily	202	20.2
Hours on internet daily	Almost not	157	15.7
	Within 1 hour	168	16.8
	1 to 2 hours	152	15.2
	2 to 3 hours	155	15.5
	3 to 4 hours	122	12.2
	More than 4 hours	247	24.7
Occupation of the main economic resource of the family	Agriculture and farming	45	4.5
	Medical and social welfare	48	4.8
	Culture and leisure	22	2.2
	Public administration	53	5.3
	Utilities	10	1.0
	Transportation and communication	22	2.2
	Education	100	10.0
	Mining	8	0.8
	Manufacturing	158	15.8
	Constructing	41	4.1
	Wholesale and retailing	61	6.1

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Demographics		Number (person)	Ratio (%)
Occupation of the main economic resource of the family	Lodging and food	69	6.9
	Finance and insurance	164	16.4
	Real estate and leasing	34	3.4
	Technology	71	7.1
	Others	95	9.5
Source of income	Single income	467	46.7
	Double income	534	53.3
Average family monthly income	Under NT\$ 26,000	124	12.4
	NT\$26,001~48,000	288	28.8
	NT\$48,001~67,000	226	22.6
	NT\$67,001~90,000	158	15.8
	NT\$90,001~150,000	164	16.4
	Above NT\$150,001	41	4.1
Family type	Single-person household	103	10.3
	Couple without children	136	13.6
	Single-parent	81	8.1
	Nuclear	506	50.5
	Grandparent-grandchild	55	5.5
	Extended	119	11.9
	Others	1	0.1
Have children aged Under 6 years	No	801	80.0
	Yes	200	20.0
Have children aged Between 6 to 18 years	No	643	64.2
	Yes	358	35.8
Have children aged Above 18 years	No	651	65.0
	Yes	350	35.0
Have seniors aged above 65 years	No	809	80.8
	Yes	192	19.2
Have disabled members	No	953	95.2
	Yes	48	4.8

## 5.2 Statistical analysis of the extent of importance and demand

Table2 Statistical analysis of the extent of importance and demand

Functions			The extent of Importance		The extent of demand		Rank
			Mean	S.D.	Mean	S.D.	
S A F E T Y	1	Interacting with kids through the screen.	3.66	1.01	3.47	1.11	
	2	Warning of overload in electricity.	4.40	0.78	4.23	0.84	3
	3	Warning of wet floor.	4.04	0.88	3.87	0.97	
	4	Warning of gas leaking.	4.56	0.74	4.36	0.84	1
	5	Warning of kid's approaching the hot soup.	4.37	0.81	4.13	0.96	
	6	Advanced design of children's safety in gas oven.	4.45	0.75	4.14	0.96	
	7	Advanced design of children's safety in cabinets.	4.25	0.79	4.02	0.98	
	8	Gas oven-timer.	4.41	0.76	4.22	0.85	4
	9	Automatically switching off the gas stove when fire goes out.	4.46	0.76	4.30	0.86	2
	10	Switching on the range hood first, then the gas oven can be turned on.	4.07	0.91	3.94	0.97	
	11	Informing gas leaking through mobile phone message.	4.18	0.91	4.01	0.96	
H E A L T H	12	Consulting food information through computer or mobile phone.	3.37	0.94	3.32	1.01	
	13	Providing dietary suggestions based on different situations or diseases through computer nutrition system.	3.52	0.90	3.45	0.97	2
	14	Calculating the calorie and nutritious facts of the take-out foods through computer.	3.33	0.95	3.26	1.02	
	15	Informing the expiring food through phone call or mobile phone message.	3.30	1.03	3.27	1.07	
	16	Informing abnormal temperature of the refrigerator through phone call or mobile phone message.	3.34	1.03	3.42	1.05	3
	17	The function of weighting and fat detecting of the dinning chair.	3.24	1.02	3.29	1.04	
	18	Usable memo system for the aged people in the home.	3.89	0.94	3.68	1.00	1
E N E R G Y	19	Controlling the lights of other rooms or aisles in any room of the home.	3.41	1.00	3.42	1.04	3
	20	Controlling the lighting system through internet when out of the home.	3.37	1.05	3.35	1.08	
	21	Monitoring the electric appliances' situation through computer or mobile phone.	3.46	1.02	3.41	1.04	

S A V I N G	22	Controlling different room's temperature and lighting through computer or mobile phone.	3.25	1.05	3.25	1.09	
	23	Informing that the refrigerator's door is not tightly closed through computer or mobile phone.	3.50	1.02	3.45	1.04	1
	24	Indicating the consumed electricity of the kitchen through computer.	3.51	1.06	3.43	1.08	2
C O N V E N I E N C E	25	Checking the amount and expiration date of the food in the refrigerator and cabinets through computer or mobile phone.	3.27	1.00	3.22	1.05	
	26	Showing food menu selecting and purchasing list through the refrigerator's screen.	3.24	0.97	3.23	1.03	
	27	Speed message by hand writing through the interacting screen of the kitchen.	3.41	1.02	3.36	1.05	2
	28	Communicating with the visitors and opening the door through the interacting screen of the kitchen.	3.47	1.03	3.33	1.03	3
	29	Dialing out and answering the phone through the interacting screen of the kitchen.	3.49	1.02	3.43	1.02	1
	30	Dining and chatting with the remote family members through the interacting screen of the kitchen.	3.31	1.05	3.22	1.09	
C O M F O R T	31	Dinning chair's automatic homing function for user's convenience.	3.21	1.13	3.14	1.15	2
	32	Detecting the user's figure and adjust to the most comfortable position of the wisdom dinning chair.	3.29	1.07	3.22	1.12	1
	33	Automatically indicating the user's e-mail through the wisdom dinning table.	2.95	1.05	2.94	1.09	
	34	The entertaining function of the wisdom dinning table.	3.03	1.03	3.01	1.09	3
	35	The typesetting function of the wisdom dinning table.	2.97	1.05	2.94	1.10	
	36	The interacting, remote information exchanging and game playing function of the wisdom dinning table.	2.90	1.10	2.87	1.13	

### 5.3 Importance-Demand Analysis

The Importance-Performance Analysis (IPA) framework was introduced by Martilla and James(1977) in marketing research in order to assist in understanding customer satisfaction as a function of both expectations concerning the significant attributes and judgments about their performance. Analyzed individually, importance and performance data may not be as meaningful as when both data sets are studied simultaneously (Graf, Hemmasi, & Nielsen, 1992). Hence, importance and performance data are plotted on a two dimensional grid with importance on the y-axis and performance on the x-axis. The data are then mapped into four quadrants (Bacon,



2003; Martilla & James, 1977).

This study applies IPA approach and modifies it into importance- demand analysis. In quadrant 2, importance is high and demand is also high, indicating the existing systems require urgent corrective action and thus should be given top priority. Items in quadrant 1 indicate low importance and high demand, this quadrant is labeled as “Concentrate Here”, which indicates that existing systems have strengths and should being promoted. In contrast, the category of low importance and low demand items makes the third quadrant labeled as “Low Priority”. While the systems with such a rating of the attributes do not pose a threat they may be candidates for discontinuation. Finally, quadrant 4 represents high importance and low demand, which suggests insignificant strengths and a possibility that the resources invested may better be diverted elsewhere.

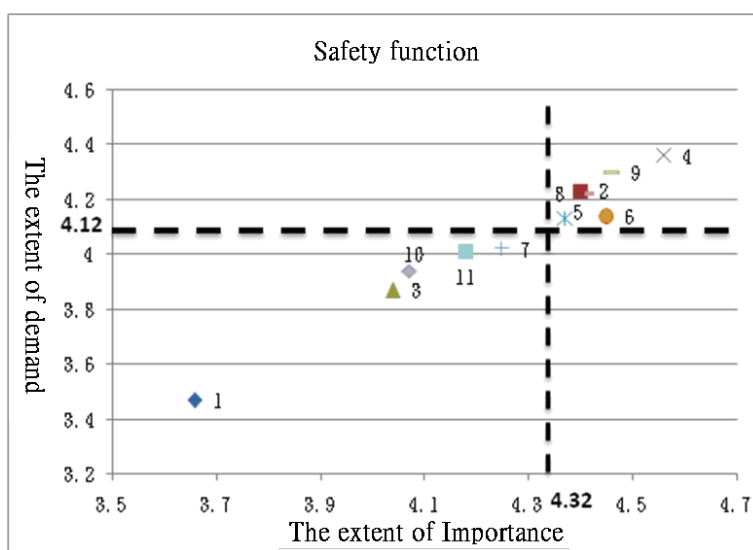


Figure 1 Safety function

Based on figure 1:

1. Functions like: Warning of overload in electricity, warning of the gas leaking, warning of children’s approaching the hot soup, advanced design of children’s safety in gas oven, gas oven-timer and automatically switching off the gas stove when fire goes out are located in the 2nd quadrant, it indicates that the respondents think the factors are both important and necessary, the results may be an important reference for designers.
2. Interacting with children through the screen, warning of wet floor, advanced design of children’s safety in cabinets, switching on the range hood first, then the gas oven can be turned on, informing gas leaking through mobile phone message. The above functions are located in the third quadrant, it shows that the respondents think the factors are not important and less necessary; they are also the indicators that designers may utilize to improve the function or enhance the product to attract customers.

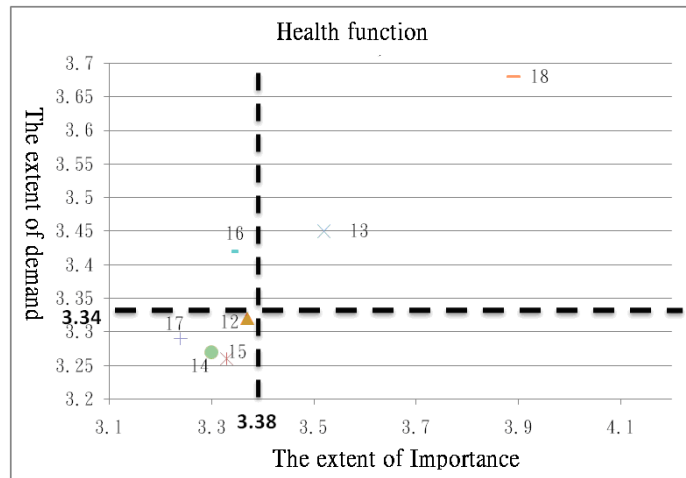


Figure 2 Health function

Results of figure 2 indicate:

1. Functions of providing dietary suggestions based on different situations or diseases through computer nutrition system and usable memo system for the aged people in the home are located in the 2nd quadrant, it implies that the respondents think the functions are both important and necessary. Designers need to regard them as important referential factors.
2. Function of informing abnormal temperature of the refrigerator through phone call or mobile phone message is located in the 1st quadrant, it represents that the function is necessary but not so important. Accordingly, the function is the critical factor for the Smart Kitchen's future development; designers should improve the shortcomings of the function to increase the product's importance.

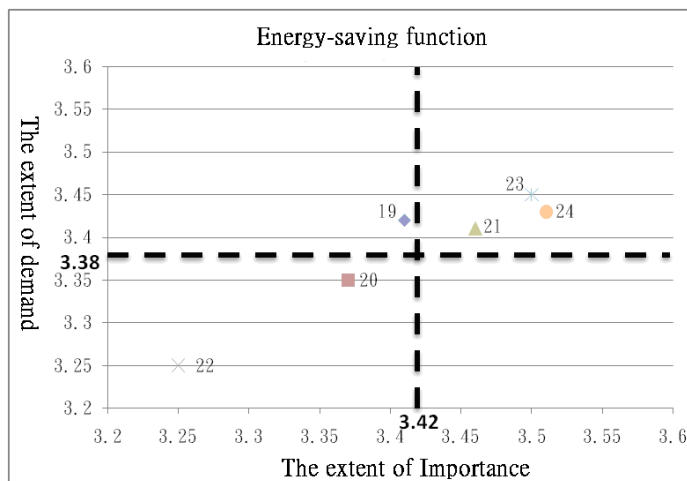


Figure3 Energy-saving function

Findings of figure 3 are:

1. Functions of monitoring the electric appliances' situation through computer or mobile phone, informing that the refrigerator's door is not tightly closed through computer or mobile phone and indicating the consumed electricity of the kitchen through computer are located in the 2nd quadrant, it indicates that the respondents think the factors are both important and necessary, so they can be the designers important referential indicators.
2. Function of controlling the lights of other rooms or aisles in any room of the home is located in the first quadrant; it shows that the function is not important but necessary, so the function plays a critical role in the product's future development. The designers should notice that maybe it's necessary nowadays, but not to enhance the product's importance in the future.
3. Functions of controlling the lighting system through internet when out of the home, and controlling different room's temperature and lighting through computer or mobile phone are located in the third quadrant, it represents that the respondents think that the factors are less important and not so necessary. The designers should regard the factors as important indicators to increase the product's value to attract customers in the future.

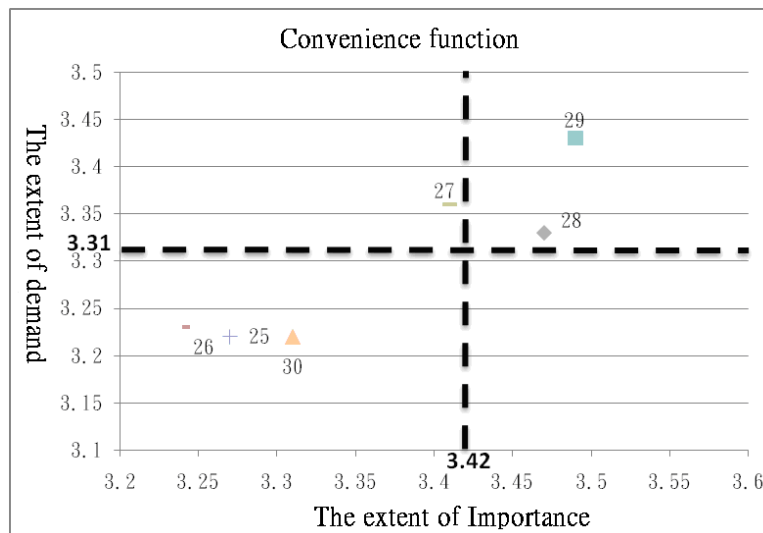


Figure 4 Convenience function

The results of figure 4 indicate:

1. Functions of dialing out and answering the phone through the interacting screen of the kitchen, and communicating with the visitors and opening the door through the interacting screen of the kitchen are located in the 2nd quadrant, it means that the respondents think that the factors are both important and necessary, they can be the designers important referential factors when designing.
2. Function of speed message by hand writing through the interacting screen of the kitchen is located in the first quadrant; it indicates that the respondents think that the factor is necessary but less important. So the designers should improve the shortcomings of the factors to increase the degree of importance.
3. Functions of checking the amount and expiration date of the food in the refrigerator and cabinets through computer or mobile phone, and dining and chatting with the remote family

members through the interacting screen of the kitchen are located in the third quadrant, this indicates that the respondents think the factors are less important and not so necessary, so the designers should regard them as important indicators to improve the quality and increase the product's value in the future.

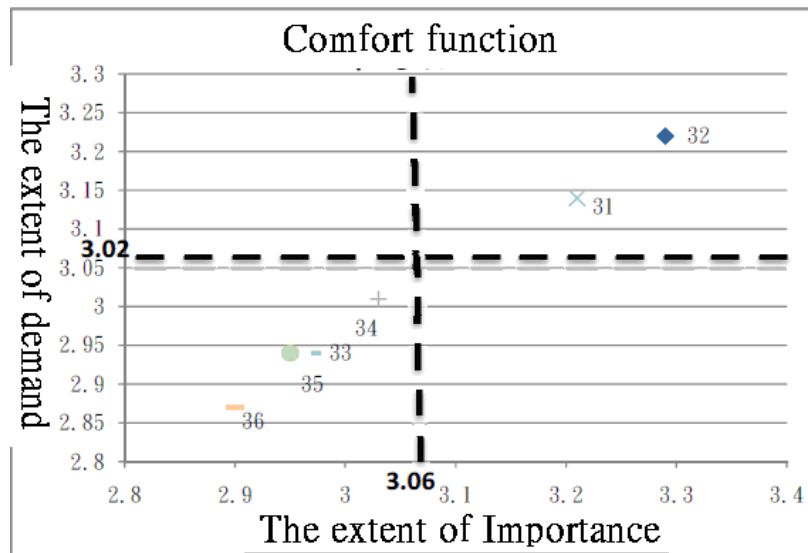


Figure 5 Comfort function

From figure 5, we can find:

1. Functions of dinning chair's automatic homing function for user's convenience, and detecting the user's figure and adjust to the most comfortable position of the wisdom dinning chair are located in the 2nd quadrant, it indicates that the respondents think the factors are both important and necessary, so the designers can regard them as important indicators when designing.
2. Functions of automatically indicating the user's e-mail through the wisdom dinning table, the entertaining function of the wisdom dinning table, the typesetting function of the wisdom dinning table, and the interacting, remote information exchanging and game playing function of the wisdom dinning table are located in the third quadrant, it reports that the respondents think the factors are less important and not so necessary, so the designers may improve them to increase the product's function and value in the future.

## 5.4 Discussion

The study employed independent sample T statistical test to examine if there exists significant difference of the average scores between the samples' demographics (include: gender, occupation, hours of internet, family type, number of children aged under 6, and number of adults aged above 65) and technology acceptance. The results of table 3 showed some interesting issues listed as the following:

1. The users of “high technology acceptance” tend to have higher demand toward the five dimensions of kitchen: safety, health, energy-saving, convenience and comfort. For those who have higher acceptance toward technological products, the facilitation of the Smart Kitchen would be utilized more.
2. Those users who use Internet more than 4 hours a day tend to have higher demand on dimensions such as: safety, health, energy-saving, convenience and comfort. For they have used to utilize the equipments of computer and Internet, meanwhile, they also have higher demand on ubiquitous service provided by the Smart Kitchen.
3. Gender: It was supposed that gender would make significant difference on demand of the Smart Kitchen; however, the results of T test indicated that the difference is not significant.
4. Users have family members aged above 65 tend to have higher demand on dimension of health, it is estimated that in the aging society, users need to take care of the health of aged people and overcome the inconvenience of daily lives caused by aging.
5. Core family is the mainstream type of the society, yet the other types (such as single family or extended family) do not make significant difference on the demand of functional dimensions of the Smart Kitchen. Probably it is because the number of the family type is few; their demand does not make any significant difference when compared with that of core family.

Table 3 Independent sample T test(n=1001)

Independent Variable		Safety		Health		Energy-saving		Convenience		Comfort	
		Average Score	T test	Average Score	T test	Average Score	T test	Average Score	T test	Average Score	T test
Technological acceptance	High	4.20	<b>4.05***</b>	3.54	<b>9.05***</b>	3.61	<b>9.64***</b>	3.58	<b>11.59***</b>	3.32	<b>12.05***</b>
	Low	4.02		3.06		3.09		2.97		2.63	
Resource Of Income	Single income	4.20	1.64	3.44	<b>1.89*</b>	3.49	<b>1.92*</b>	3.42	<b>2.01*</b>	3.11	1.43
	Double income	4.10		3.31		3.36		3.29		3.00	
Gender	Male	4.07	1.17	3.31	0.54	3.38	0.02	3.33	-0.19	3.06	-0.62
	Female	4.13		3.34		3.38		3.31		3.01	
Internet hours	Less than 4 hours	4.07	<b>-4.39***</b>	3.27	<b>-4.48***</b>	3.31	<b>-5.12***</b>	3.23	<b>-5.68***</b>	2.95	<b>-4.13***</b>
	More than 4 hours	4.29		3.54		3.61		3.58		3.24	
Child aged under 6	No	4.11	-1.16	3.36	1.69	3.39	0.71	3.32	0.18	3.05	1.66
	Yes	4.18		3.24		3.34		3.30		2.92	
Adult aged above 65	No	4.10	-1.76	3.31	<b>-2.03*</b>	3.36	-1.93	3.29	<b>-2.01*</b>	3.00	-1.42
	Yes	4.20		3.44		3.49		3.42		3.11	
Family type	Core family	4.13	-1.00	3.33	-0.62	3.36	-1.51	3.32	-0.24	3.01	-0.20
	Extended family	4.20		3.38		3.49		3.34		3.03	
Family type	Core family	4.10	-0.30	3.27	1.52	3.42	0.55	3.27	-0.60	3.09	0.76
	Single family	4.13		3.33		3.36		3.32		3.01	

## VI. Conclusion

This chapter is going to make a conclusion based on the results of chapter 4 and 5 with the attempt to help the designer to understand the main user's demand of the Smart Kitchen as well as remind the future designer to realize that both the opinion of the main user and other members of the family should be considered as an important factor when designing the system. Further research directions and suggestions are provided for future researchers finally.

The difference of kitchen usage between housewives and career women could be the reference of market segmentation and the base of making marketing strategy. Under the lifestyle of modern business society, people are always busy, family members need time and space to interact, and kitchen is therefore the place for dining and parent-kid's interaction and communication. Hence, spatial layout is one of the points to design the Smart Kitchen. Notably, safety remains the most urgent needs when designing the Smart Kitchen based on the suggestions provided by the users. In a housing space, an interactive monitor is necessary because females also hope to take good care of kids when they are working in the kitchen.

The objective of the research is to explore the main user's extent on the Smart Kitchen's importance and demand. The respondents of the questionnaire mainly come from the five metropolitan and two sub-metropolitan areas that equipped with computer and internet facilitation in Taiwan. The results are analyzed by independent sample t-test and are explained as the following:

The extent of importance and demand of the Smart Kitchen in terms of the main user: The results indicated that the importance and extent of demand on functions and equipments of the Smart Kitchen is positively pair wised correlated. Those who regard the functions and equipments of the Smart Kitchen as important factors have higher demands.

The extent of importance and demand of the Smart Kitchen in terms of the main user: The results showed that in safety dimension, the respondents think the factors (such as gas and electricity) are both important and necessary; in health dimension, the respondents think the functions (for example: computer nutrition system and usable memo system) are both important and necessary; in energy-saving dimension, the respondents think the factors (like monitoring the electric appliances' situation through computer or mobile phone, informing that the refrigerator's door is not tightly closed through computer or mobile phone) are both important and necessary; in convenience dimension, the respondents think that the factors (such as: dialing out and answering the phone through the interacting screen of the kitchen, and communicating with the visitors and opening the door through the interacting screen of the kitchen) are both important and necessary; in comfort dimension, the respondents think the factors (for example: dinning chair's automatic homing function for user's convenience, and detecting the user's figure and adjust to the most comfortable position of the wisdom dinning chair) are both important and necessary. The above stated functions could be designer's important factors when designing the system.

The factor's ranking of the main user's attitude toward the function and demand of the Smart Kitchen is as the following: safety (average score: 4.12); energy-saving (average score: 3.38); health (average score: 3.34); convenience (average score: 3.31); comfort (average score: 3.02). The cooking activities need to utilize electricity and gas, so the users regard safety as the

first important factor on evaluating the Smart Kitchen system; secondly, as the price of energy is keeping going up, energy-saving is the prevalent thinking in the era of green consuming; thirdly, the full-employed respondents accounts for more than seventy percent of the whole respondents, they do hope the Smart Kitchen can have the health-oriented function and be able to maintain family member's health in modern business society; finally, the degree of convenience is slightly higher than that of comfort, it is because that modern women play the roles of occupational women and house mothers, they are the primary manpower of the family, the cleaning and fixing of the kitchen takes a lot of efforts, so if the Smart Kitchen possesses the function of convenience, it will surely be popular. Meanwhile, the function of comfort is ranked the last in terms of necessity, the situation right matches Maslow's Theory of needs hierarchy, which states that when human's basic needs are satisfied, they'll seek for higher level needs. Similarly, kitchen's functions need to get advanced from basic needs to enjoyed needs.

Family members on the importance and demand of the facilitation of the Smart Kitchen: the results indicated that there exists significant difference on each functional dimension in technological acceptance and Internet hours. When the participants have higher demand in technological acceptance, they tend to have higher demand on each functional dimension; the participants who use Internet more than 4 hours tend to have higher demand toward each functional dimension of the Smart Kitchen than those who use Internet less than 4 hours. Besides, the participants who have family members aged above 65 tend to have higher demand towards the dimensions of health and convenience, it is estimated that it is because that in the aging society, the aged people need to be specially taken care of and some of the inconvenience in their daily lives need to be overcome. However, the participants who have family members aged under 6 did not bring any significant difference for the result. Therefore, the above stated difference may be a critical reference for marketers when making segmentation strategies for special market.

The daily activities generate vitality because of human; the so-called dwelling is transformed to be "home" for the sake of people. Therefore, the function of kitchen should not be limited in the scope of cooking only, it should be empowered to have the functions of daily dining, family member's affection connection, health concerning as well as the place of life enjoyment. The study suggests that future research should combine the related issues such as gender, family life cycle, family member's job to explore the difference on the function of kitchen's demand and expectation.

The Smart Kitchen used many electronic appliances, which leads to a confliction with the concept of "energy saving and carbon reduction". We suggest that both of "wisdom" and "green" should be taken into consideration when designing the system in the future.

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